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An Experimental Study on Strength of Concrete with Silica Fume and Partial Replacement of Cement by Brick Powder

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Abstract:- Brick powder and other waste particles not only occupy land but also create environmental problems. The problem could be reduced to a large extent by using these waste materials in cement concrete. The reason of using brick powder include economical gain. Experimental results indicate that brick powder could be used for partial replacement of cement in concrete. Cement is replaced by waste brick powder in different proportions 5% 10% 15% and 20%. Silica fume is added 10% of concrete. To determine the mechanical properties such as compressive strength, flexural strength, split tensile strength and durability test. The presence of brick powder shows that certain properties of concrete could be improved by using brick in combination with ordinary Portland cement. In this study physical properties of cement, brick powder, fine and coarse aggregate, and silica fume are studied. Specific gravity, sieve analysis, bulk density, bulking of sand, water absorption, moisture content test, fineness of cement, cement consistency initial and final setting time of cement were tested.

I. INTRODUCTION

Concrete is a composite material composed mainly of water, aggregates and cement. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. Brick powder are not commonly used in construction industry but are often dumped as industrial wastes. These brick powder protects the environment surroundings. Brick powder can be used as substitute for conventional cement in concrete production. Brick powder reduces the weight of the concrete. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cube beam and cylinder are compacted on a vibrating table. Current researches demonstrate that concrete could be produced with cement partially substituted by waste brick powder. Partially replacing cement with other materials without compromising the properties of concrete is one of the effective ways to make concrete more sustainable.

II. EXPERIMENTAL PROGRAMME

A. Materials

Concrete was made of ordinary Portland cement 43 grade, Fine aggregate (natural river sand), Coarse aggregate, Water , brick powder, and silica fume.

B. Cement

Specific gravity of cement -3.15

Properties	Results
Type of cement	OPC 43
Fineness	7%
Nominal consistency	29%
Intial setting time	30min

Table 1. Test Results on Cement (Is 12269-1987)

C. Fine Aggregate

Properties	Results
Specific gravity	2.8
Fineness modulus	2.7
Moisture content	1.45
Water absorption	15%
Bulking sand	4%

Table 2. Test Results on Fine Aggregate

D. Coarse Aggregate

Properties	Results
Specific gravity	2.7
Fineness modulus	6.14
Moisture content	15%
Water absorption	23%

Table 3. Test result on coarse aggregate (IS 383-1970)

E. Silica Fume

Silica fume is also known as micro silica. It is an ultra fine material with spherical particles less than 1 μm. In this project 10% of cement is replaced by silica fume.

Properties	Results
Specific gravity	2.25
Bulk density	430Kg/m
Particle size	1μm

Table 4. Test result on silica fume

F. Brick Powder

Brick powder reduce the weight of the concrete. Increase in construction activities. Brick crushed in coarse powder were used in cement for making concrete. With proper mix design concrete with brick powder will increase the strength. As curing age increases the compressive strength will be increased.

Properties	Results
Specific gravity	2.2
Bulk density	520 Kg/m^3

Table 5. Test result on brick powder

G. Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. The quantity and quality of water is required to be watched into carefully so that it can form the strength giving cement gel. Portable water is used for making mortar. The pH value of water lies between 6 and 8 that indicate the water is free from organic matters. Water is needed to chemically react with the cement (hyration) and to provide workability with the concrete

H. Mix Proportions

Design grade of concrete: M30 (as per IS :456-2000)

Cement: Fine aggregate: Coarse aggregate: Water - 1: 1.74: 2.49:0.45

SPECIMEN	CEMENT	FA	CA	WA	BP	SF
CUBE	12.43	25.50	36.5	6.5	0.7	1.46
CYCLINDER	19.4	40.06	57.4	10.3	1.2	2.29
PRISM	18.41	37.78	54.1	9.75	1.1	2.16

Table 6. Concrete Mix Proportions for 5% Replacement of Concrete by Brick Powder

SPECIMEN	CEMENT	FA	CA	WA	BP	SF
CUBE	11.69	25.50	36.5	6.5	1.46	1.46
CYCLINDER	18.34	40.06	57.4	10.3	2.29	2.29
PRISM	17.33	37.78	54.1	9.75	2.17	2.16

Table 7. Concrete Mix Proportions for 10% Replacement of Concrete by Brick Powder

SPECIMEN	CEMENT	FA	CA	WA	BP	SF	
CUBE	10.96	25.50	36.5	6.5	2.19	1.46	
CYCLINDER	17.20	40.06	57.4	10.3	3.44	2.29	
PRISM	16.24	37.78	54.1	9.75	3.25	2.16	

Table 8. Concrete Mix Proportions for 15% Replacement of Concrete by Brick Powder

SPECIMEN	CEMENT	FA	CA	WAT	BP	SF
CUBE	10.23	25.5	36.5	6.5	2.9	1.46
CYCLINDER	16.08	40.0	57.3	10.3	4.5	2.29
PRISM	15.19	37.8	54.1	9.7	4.3	2.16

Table 9. Concrete Mix Proportions for 15% Replacement of Concrete by Brick Powder

III. TEST METHODS

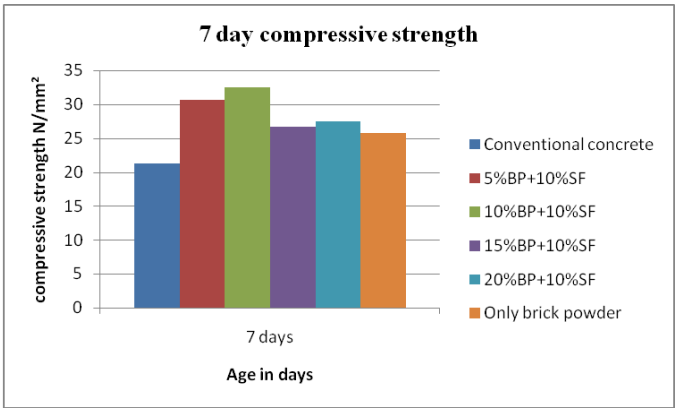
The compressive strength, tensile strength, and flexural strength of various concrete mixtures were determined on 150×150mm cubes, 150×300mm cyclinders and 100×100×500 prism respectively

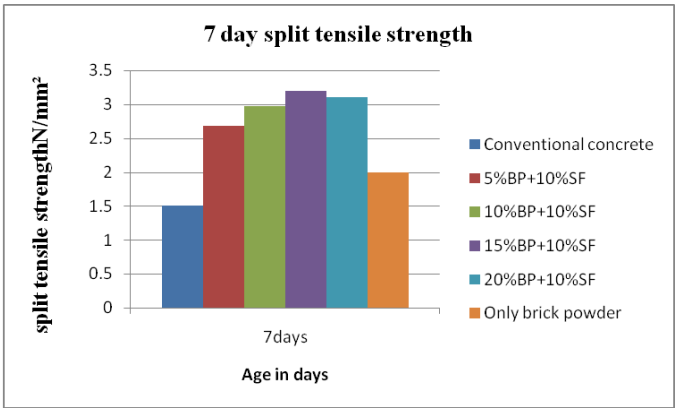
Cement+BP+SF	7days(N/mm²)	14days(N/mm²)	28days
5%BP+10%SF	30.66	17.55	25.66
10%BP+10%SF	27.22	39.55	44.1
15%BP+10%SF	26.6	28.8	38.8
20%BP+10%SF	27.5	28.4	28.44

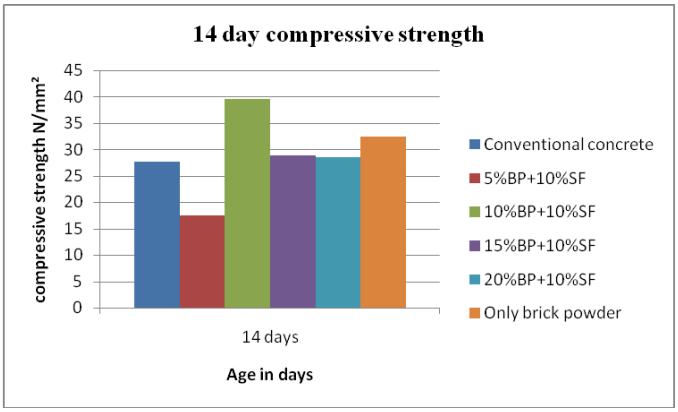
Table 10. Compressive Strength of the Concrete Mixtures (BP+SF)

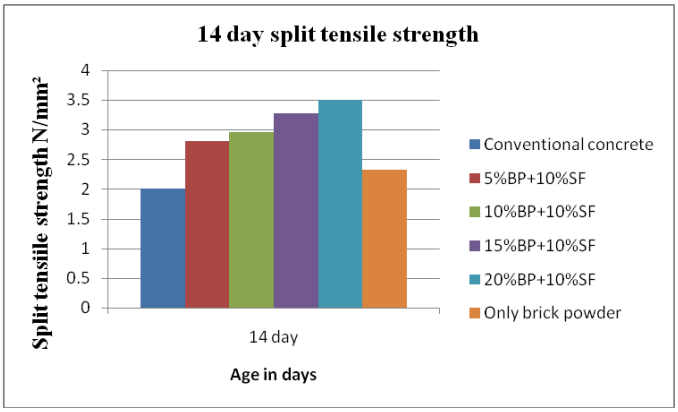
Cement+BP+SF	7days(N/mm²)	14days(N/mm²)	28days(N/mm²)
5%BP+10%SF	2.68	2.81	3.24
10%BP+10%SF	2.97	2.96	3.67
15%BP+10%SF	3.19	3.27	3.69
20%BP+10%SF	3.10	3.50	4.02

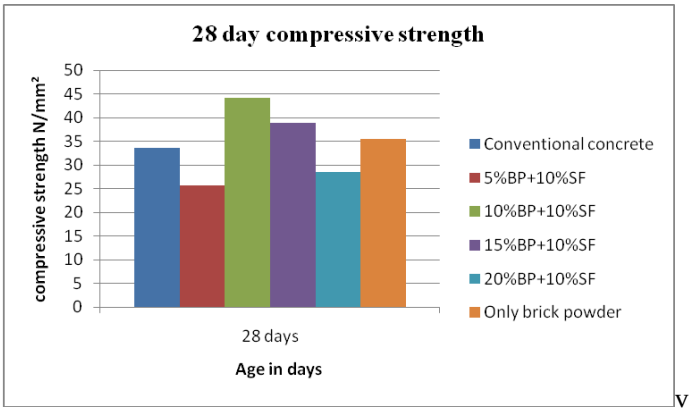
Table 11. Split tensile strength of the concrete











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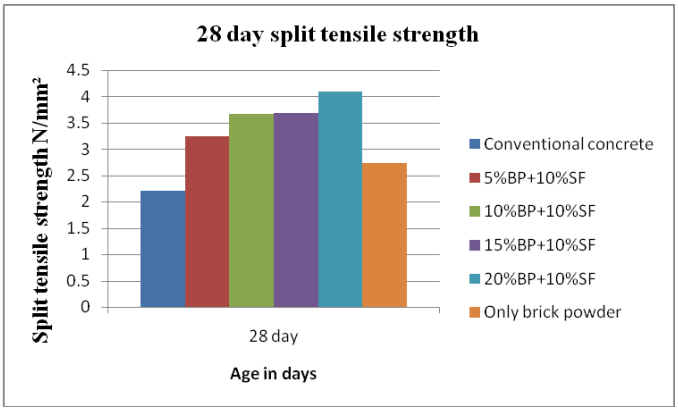
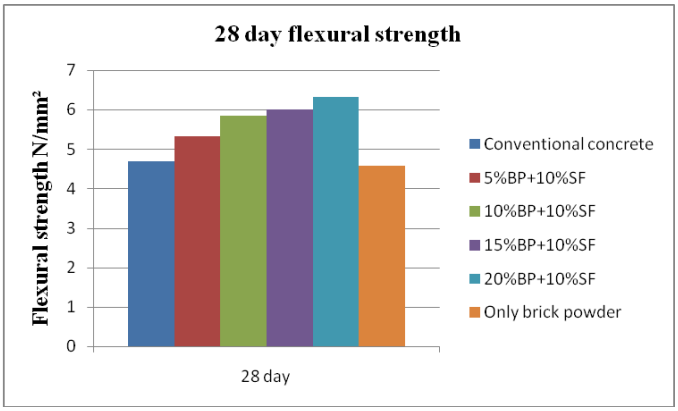
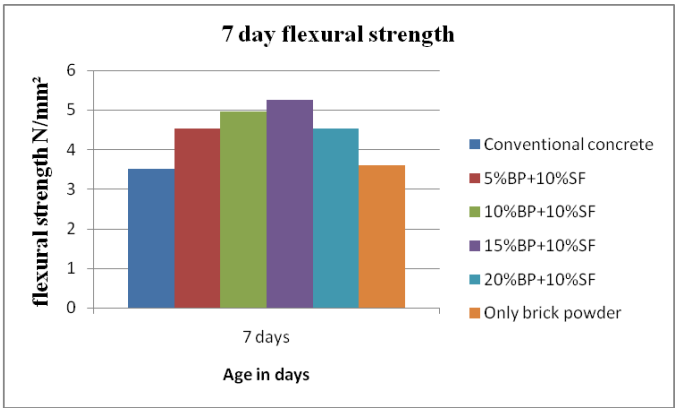
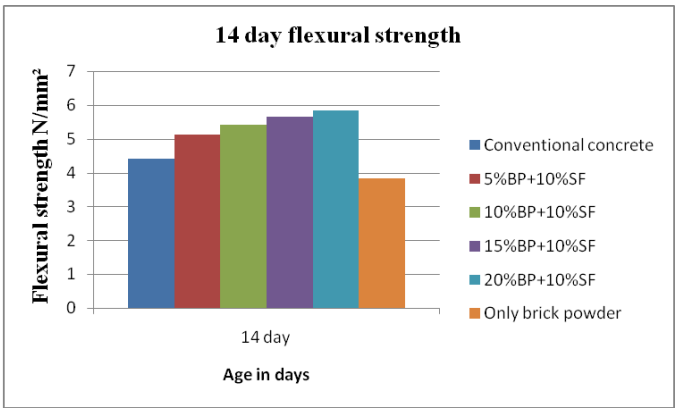


Cement+BP+SF	7days	14days	28days	
5%BP+10%SF	4.52	5.12	5.93	
10%BP+10%SF	4.95	5.42	5.84	
15%BP+10%SF	5.25	5.65	6.00	
20%BP+10%SF	5.35	5.84	6.32	

Table 12. flexural strength of the concrete





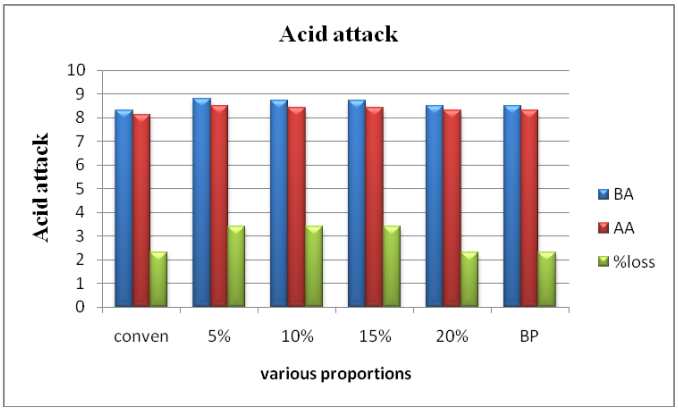


➢ *Durability test*

- *Acid attack*

The 60th day durability test was also conducted. The specimen are cast in and cured in mould for 24hrs. After 24hrs all the specimen are demoulded and kept in curing tank for 7days. After 7days all specimens are kept in atmosphere for 2 days in constant atmosphere. Subsequently the specimens are weighted and immersed 5% hydrochloric acid for 60 days. The PH value of the acidic media was 2. After 60 days of immersing in acid the specimens are taken out and were washed in running water and kept in atmosphere 2 days for constant weight. The specimens are weighted and loss in weight.

SPECIMEN	Cube weight Before acid	Cube weight After acid	%Loss of weight
Conventional concrete	8.29	8.1	2.29
5%BP+10%SF	8.8	8.5	3.4
10%BP+10%SF	8.7	8.4	3.4
15%BP+10%SF	8.7	8.4	3.4
20%BP+10%SF	8.5	8.3	2.3
Only brick powder	8.5	8.3	2.3



IV. CONCLUSION

- From the literature survey, it is observed that the concrete with brick powder gives better strength and workability.
- It was observed that the material properties such as cement, coarse aggregate, and fine aggregate satisfied as per the codal provision.
- In the present study, an attempt is made to replace the cement with industrial waste like brick powder.
- The use of waste materials like brick powder and silica fume in construction industry reduces the cost, pollution and the problems related to the disposal of waste material.
- The strength characteristics has developed more when compared with brick powder due to presence of high percentage of alumina and silica content with less percentage of calcium content in the material properties.
- The replacement of cement by brick dust appears to increase the strength of concrete.
- Under acid attack, performance of cement concrete cube specimen prepared with 5% 10% 15% and 20% cement replaced by brick powder.

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